

Investigating Pest Birds Problems and Potential Solutions in Sawah Ring, Tangkak

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Abstract

In the agricultural sector, especially paddy fields, birds are considered pests when they destroy the paddy plants by eating the grains and reducing crop production. Pest birds are a common problem in agriculture. Nevertheless, studies of the pest birds, particularly on their distribution, ecology, and management, are still scarce in Malaysia. One of the significant pest birds in this case study is the Purple Swamphen (*Porphyrio porphyrio*). The objectives of this study are (1) to identify pest birds species (2) to investigate the behaviour of Purple Swamphen (*Porphyrio porphyrio*) and (3) to provide potential solutions for pest birds problems to local farmers at Sawah Ring, Tangkak. The methods used were direct observation using binoculars, spotter scope, and a digital camera. Besides that, a survey through the distribution of questionnaires and interviews was also conducted among the local people at the study site. Five species of pest birds have been recorded, which are, Purple Swamphen (*Porphyrio porphyrio*), Lesser Whistling Duck (*Dendrocygna javanica*), Scaly-breasted Munia (*Lonchura punctulata*), Javan Munia (*Lonchura leucogastroides*) and Baya Weaver (*Ploceus philippinus*). From the list, Purple Swamphen (*Porphyrio porphyrio*), was identified as the most disturbing pest bird. The occurrence of this species were marked at Block 1, Block 3, Block 15, Block 16, Block 18, and Block 19 at Sawah Ring, Tangkak, and the species' behaviour (resting, nesting, feeding, etc.) was also recorded. In terms of solutions, several methods have been identified to overcome the pest bird problem based on the literature studies, such as physical and chemical repellent, buzzer and mesh networks, and also acoustic tools. Overall, pest birds are a significant problem in the paddy field areas of Sawah Ring, Tangkak. It reduced the quantity and quality of paddy production and caused losses to farmers. Understanding the occurrence and behaviour of pest birds is indeed crucial for better management of these pest bird species.

1. Introduction

The principal staple food and food crops of Malaysia, paddy, and rice have been the centerpiece of the country's self-sufficiency policy. Throughout the Eleventh Malaysian Plan (2016-2020) and National Agro-Food Policy (2011-2020), Malaysia continues its proactive and innovative steps to boost paddy and rice sector growth [1].

Despite all the efforts, Malaysia's agriculture sectors are still threatened due to several factors, including pests. Birds are considered pests if they cause harm to people or their social structures, cause a threat to the new environment, and as deviants that act inappropriately [2]. The majority of species are only deemed socially problematic when and where they turn into pests [3]. Farmers may experience losses in agricultural output as a result of avian interference in agriculture. A reduction in harvest output occurs due to the projected grazing bird population, which prefers agricultural fields over their native foraging habitats since crops offer better food [4]. In other countries, such as Sweden, a government-approved compensation procedure that allows farmers to report agricultural harm brought on by huge grazing birds and get cash compensation. It is necessary to approve reported damages there [5]. The results from the survey and acceptance of 2,194 damage complaints by Inspectors from the Swedish CABs between 2000 and 2015 led to a yield loss of 34,500 metric tonnes. A total of 3.4 million euros, or 88%, were distributed to impacted people, as a result of damage done by the pest birds, the Barnacles Goose (*Branta leucopsis*), Common Cranes (*Grus grus*), and Greylag Geese (*Anser anser*).

Farmers frequently struggle with the problem of pest birds in agriculture. However, there is relatively little research on pest birds in Malaysia, particularly those that focus on their distribution, ecology, and management. It is essential to comprehend the context of the local community's pest bird problem because this will help identify viable remedies. Therefore, this study aims to identify the pest birds and the issues they are causing, to investigate the behaviour of Purple Swamphen (*P. porphyrio*) as a significant pest bird and to offer alternative solutions that local populations can employ in the paddy field at Sawah Ring, Tangkak, based on literature studies.

2. Methodology

2.1 Study Area

The agricultural area at Sawah Ring, Tangkak (2.2280° N, 102.6823° E), Johor [6] is a location with significant pest birds concerns (Figure 1). Sampling were conducted between months of August to October, 2022.

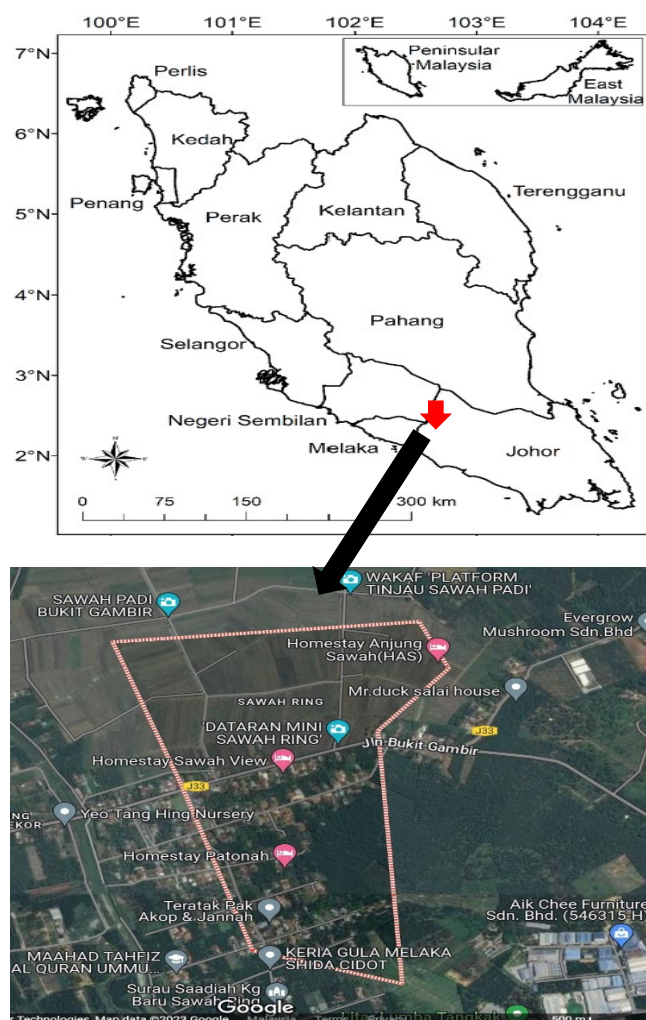


Fig. 1 Map of Sawah Ring, Tangkak

2.2 Direct Observations

A pair of binoculars (12 x 42 magnification), a spotting scope, a video recorder, and a digital camera were employed in this investigation for direct observation. Data on pest bird species, their seasonal occurrence, and activity were logged. A field reference to the birds of Peninsular Malaysia and Singapore was used to identify the birds from the photograph [7].

2.3 Questionnaire

The majority of the locals, who are farmers, received a set of questionnaires with both open-ended and closed-ended questions. In this questionnaire, questions about the respondents' demographics and a general understanding of pest and pest birds' problems were included. In addition, respondents were questioned regarding the species of common nuisance birds they encountered, how frequently they occurred, and the issues the birds in the study location produced. The efficiency of other information, such as the strategies employed by respondents to solve the pest bird problem, were also asked in the questionnaire.

2.4 Interview

Interviews with local farmers in the research area were also done in addition to surveys. Unstructured interviews without a specific set of predetermined questions were undertaken. Farmers were questioned about the types of pest bird species they encountered over the course of the seasons (years), the habits of the pest birds that caused harm to the rice crops, and the strategies they utilized to reduce the pest bird population in their farming area. Understanding the behaviour and existing control of nuisance birds in the research location is the goal of the interview. It is thought that by understanding the ecology and behaviour of birds, improved management of pest birds, particularly for pest birds in this area, can be suggested in the future.

3. Results and Discussion

3.1 List of Pest Birds in Sawah Ring, Tangkak

In this study, five types of pest birds were found through direct observation. The species are Purple Swamphen (*P. porphyrio*), Lesser Whistling Duck (*D. javanica*), Scaly-breasted Munia (*L. punctulata*), Javan Munia (*L. leucogastroides*), and Baya Weaver (*P. philippinus*). The details of the birds are summarized in Table 1.

Table 1 List of pest birds in Sawah Ring, Tangkak

Family	Common Name	Scientific Name	Local Name	Distribution status	IUCN Status
Rallidae	Purple Swamphen	<i>Porphyrio porphyrio</i>	Pangling / Pangling Ungu	Native	Least concern
Anatidae	Lesser Whistling Duck	<i>Dendrocygna javanica</i>	Belibis / Belibis Kecil	Native	Least concern
Estrildidae	Scaly-breasted Munia	<i>Lonchura punctulata</i>	Pipit Pinang	Native	Least concern
Estrildidae	Javan Munia	<i>Lonchura leucogastroides</i>	Pipit Jawa	Introduced	Least concern
Ploceidae	Baya Weaver	<i>Ploceus philippinus</i>	Burung Tempua / Ciak Tempua	Native	Least concern

3.1.1 Frequency of Pest Birds Occurrence in The Study Area

Based on our observations, all five pest birds species have caused damage to crop due to their behaviour and activities. For example, Purple Swamphen (*P. porphyrio*) has been observed to destroy the paddy by removing it from the ground. Besides that, they used paddy fields as their home, nesting, and breeding sites. Another pest bird species, Lesser Whistling Duck (*D. javanica*), was observed frequently during planting season as they tend to feed upon the newly sown rice seeds.

The other three pest bird species, Scaly-breasted Munia (*L. punctulata*), Javan Munia (*L. leucogastroides*), and Baya Weaver (*P. philippinus*), were observed actively feeding on the grain of the paddy plants during the harvesting seasons. Table 2 shows the results of pest birds' occurrence in the study area based on observation from this study and input from farmers.

Table 2 Pest birds species occurrence in different paddy fields seasons

	Planting seasons (June and December)	Growing seasons (July- September, December-January)	Harvesting seasons (October and March)
Purple Swamphen	√	√	√
Lesser Whistling Duck	√		
Scaly-breasted munia			√
Javan munia			√
Baya Weaver			√

According to interviews with local farmers, a specific type of pest birds can be detected during each season. Lesser Whistling Ducks and Purple Swamphen are typically prevalent pest birds in this area during planting season. They would consume the seeds of the freshly planted paddy during this time. When the first month of the planting season arrives, Purple Swamphen frequency peaks. It consumes the delicate crop kernels and breaks the stalks of the crops to construct its nest for egg-laying. Only the Purple Swamphen can be found year-round among all the species encountered. Scaly-breasted Munia, Javan Munia, and Baya Weaver were frequently seen in this rice field region. These birds are all granivores. They eat grains from mature paddy fields. Different occurrence of pest bird species occurs in each season because it is closely related to the bird’s requirement, such as for nesting, feeding, and laying egg purpose. Depending on the pest species and crops, different harm durations and sensitive stages exist [8].

Lesser Whistling Duck (*D. javanica*) comes from the family Anatidae. According to previous studies, Anatidae may consume green matter as soon as leaves develop. The preferred height sward varies among crop species and is directly impacted by bird damage during field crop establishment (i.e. yield losses, reseeded expenses). In the case of waterfowl, this effect is brought on by soil trampling and puddling in addition to the ingestion of seeds and seedlings. These findings explain the behaviour of the Lesser Whistling Duck in this study [9].

In Indonesian rice fields, the Scaly-breasted Munia (*L. punctulata*) is a well-known pest [10]. This species attacks rice plants in the vegetative phase at seeding and the generative phase when rice enters the milk ripening stage until harvest. For Javan Munia (*L. leucogastroides*), the local population classified Javan Munia as paddy seed eaters and viewed them as bad birds [11]. Birds can cause crop damage and financial loss to farmers at every stage of agricultural production, from planting to harvesting. The production potential of irrigated lowland rice decreased from a potential output of 5 t ha⁻¹ to an average yield of 2.8 t ha⁻¹ due to biotic restrictions, including weaver birds [12]. Weavers are significant rice pests in Badeggi, Niger State, Nigeria [13].

Furthermore, Purple Swamphen (*P. porphyrio*) damaged the crops by stem-cutting and the emergence of bald patches in rice fields. This causes increasing amounts of damage to rice fields as its population has increased [14]. Based on the observation, all five species of birds are considered pests in the agricultural sector as they cause damage and decrease the production of crops.

3.2 The Behaviour of Purple Swamphen (*Porphyrio porphyrio*) as Pest Birds

From the interview with farmers in Sawah Ring, Tangkak, most of them agreed that among five species recorded as pest birds in this area, Purple Swamphen was the most destructive species as it occurs throughout the seasons (planting, growing, and harvesting seasons). Table 3 summarizes the behaviour of this bird based on the observation in this study. Sawah Ring covers an area of 264 hectares, each paddy field area is divided into block areas, and each block is looked after and managed by a different farmer. Among the blocks that recorded the presence of Purple Swamphen are Block 1, Block 3, Block 15, Block 16, Block 18 and Block 19 (Figure 2).

Table 3 Summary of the behaviour of Purple Swamphen recorded in the study area

Behaviour/activities	Description
Flocking behaviour	Flocking in a solitary or in a small group, usually in a pair. The distance between both individuals is usually not far, and they tend to follow the movement of each other. For example, if one individual flies to another area, the other will follow it.
Walking and uprooting newly planted rice seedlings	Purple Swamphen walks in paddy fields to find areas for laying their eggs. They also observed uprooting newly planted rice seedlings and using them to construct their nest.
Feeding behaviour	The Purple Swamphen consumes small creatures like frogs and snails as well as the tender shoots of rushes and reeds. It is known to steal eggs, though; when it can catch them, it will consume ducklings.

Resting and preening

Purple Swamphen was also observed resting and preening in the paddy field of Sawah Ring at Block 1, Block 3, Block 15, Block 16, Block 18 and Block 19.

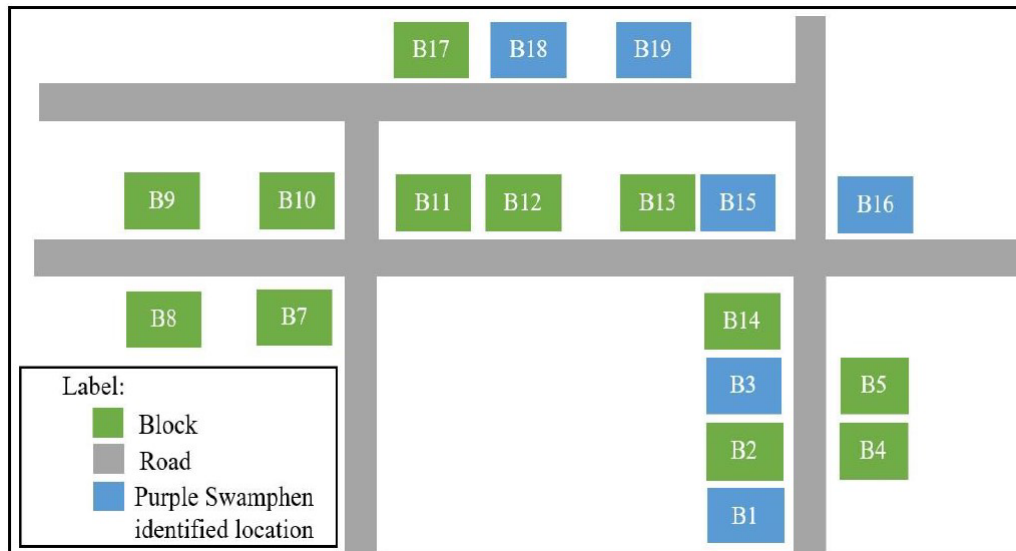


Fig. 2 The position of the paddy field blocks at Sawah Ring, Tangkak

Based on observation, some of the blocks are located close to each other. The block with the most individuals of Purple Swamphen is Block 16 (five individuals were spotted in the same block simultaneously). Usually, Purple Swamphen will hide in the middle of paddy field crops. Local farmers said that Purple Swamphen favour habitat located near the marshy rivers that are close to the small forest. This explains the abundance distribution of this species in block 16. Figure 3 shows a Purple Swamphen preening in the marshy area of Block 19. Other than that, it is also observed that each block is located close to the water line.



Fig. 3 An individual of Purple Swamphen managed to be identified at Block 19, Sawah Ring

Since 1990, this species has increased significantly in southern Europe, going from being threatened throughout the majority of the 20th century to common [15], with big groups recently being observed in a number of Iberian wetlands [16]. According to the International Union for Conservation of Nature (IUCN), Purple Swamphen is classified as Least Concern, which means the Purple Swamphen taxon has been assessed in accordance with the Red List criteria but does not meet the criteria for Endangered or Near Threatened. According to the Wildlife Conservation Act 2010 (Act 716), anyone convicted of an offense of catching a male Purple Swamphen can be fined not more than RM 100,000.00 or imprisoned for not more than three years. If the caught bird is female or immature, the party concerned can be fined up to RM 200,000.00 or imprisoned for no more than ten years.

A case study utilizing sustainable, non-lethal methods to balance the preservation of the Purple Swamphen (*P. porphyrio*) and the harm it does to Mediterranean rice fields finds it challenging to implement deterrents during the crop season when the species feels the most secure in the rice field. Due to the Purple Swamphen's particular protection under national and European law, no lethal control measures, capture, or translocations can be implemented without first demonstrating that there are no adequate alternatives available to prevent or lessen agricultural damage. In this study, they sought to determine how well three crop protection strategies which are physical barrier, falconry, and vegetation management, could prevent and lessen damage from the Purple Swamphen [17].

3.3 Potential Solution for Pest Birds Problems Based on Literature Review

3.3.1 Farmers' Perceptions Towards Pest Birds Problem Based on Questionnaire and Interview

The farmers' and local people's perception of pest birds in the paddy field of Sawah Ring was also assessed in the questionnaires. The first question asked about the farmer's perception when dealing with pest birds (Table 4) and the second question asked about estimated loss caused by pest birds (Table 5). Respondents were asked on a scale of 1 (strongly disagree) to 5 (strongly agree), did they feel angry when pest birds were present in their crop area.

Table 4 *Disappointment feeling when dealing with pest birds among local farmers*

Scale	Number of Respondent
1 (Strongly Disagree)	0 (0%)
2 (Disagree)	0 (0%)
3 (Neither Agree/Disagree)	2 (10%)
4 (Agree)	4 (20%)
5 (Strongly Agree)	14 (70%)
Total Number of Respondent	20 Respondents

The results show that 70% (14 respondents) strongly agreed, 20% (4 respondents) agreed, and 10% (2 respondents) partially agreed that they feel angry and disappointed when pest birds are present in their crop field area. Most of the respondents who are angry and disappointed with pest birds are local farmers because pest birds cause a loss in their source of livelihood. The least agreed percentage belongs to the respondents working in the government sector. Table 5 presents the estimated loss of the farmer's crop production.

Table 5 *Estimated percentage of total loss caused by pest birds at Sawah Ring, Tangkak*

Estimated Loss Caused by Pest Birds	Total of Respondents
Less than 10%	1 (5%)
Between 10-30%	6 (30%)
Between 30-50%	4 (20%)
More than 50%	9 (45%)
Total Number of Respondent	20 Respondents

Out of 20 respondents, 50% (10 respondents) estimated that the total loss due to pest birds is more than 50%, 30% (6 respondents) estimated total loss is between 10% - 30%, 20% (4 respondents) estimated that the total loss is between 30% - 50%, and 5% (1 respondent) estimated that total loss due to pest birds is less than 10%. In a nutshell, it can be said that pest birds can cause a considerable loss to rice crop production.

According to an interview with a farmer, one hectare of paddy field can produce up to three tons of crop worth RM2,100.00. Purple Swamphen caused half of the production loss which caused farmers to lose about RM1,050.00 in their crop production.

Pest birds cause significant losses to the economy and crop production. In accordance with the law, regional authorities in several Spanish wetlands are making compensation payments to farmers [18]. Administrators, for instance, in the Ebro Delta paid up to 203,450 € every year from 2003 to 2016 to make up for losses on almost 21,000 acres of rice crops [19]. In Jawa, it is possible to charge Rp.2,500,325 per hectare in Sawah Baru, Bogor, and Rp.1,064,040 per hectare in Ciherang, Bogor, for the cost of loss that farmers experience as a result of crop loss caused by Scaly-breasted Munia [20].

3.3.2 Ways Local Farmers Used to Handle Pest Birds

According to the evaluation prevention/precautionary approach to overcome the pest bird problem by farmers in Sawah Ring, Tangkak, 55% (11 respondents) suggested that setting a trap can be one of the ways to drive away pest birds, 40% (8 respondents) suggested spraying poison to crops, 25% (5 respondents) would throw stones at the pest birds, and 20% (4 respondents) used scarecrows. Besides that, farmers also used other methods, such as putting up flags, throwing firecrackers, stringing and clapping hands (Table 6). Installing traps, perhaps, is the most efficient way to prevent pests' birds from damaging crops. However, issues may arise since most pest birds, such as Purple Swamphen, are protected under Wildlife Conservation Act 2010 (Act 716). The method local farmers used did not successfully drive away pest birds forever. Therefore, the alternative is to provide potential solutions based on the previous studies.

Table 6 Results of the questionnaire show a prevention/precautionary approach to overcome the pest birds problem by farmers in Sawah Ring, Tangkak

Activities to Drive Away Pest Birds	Total of Respondents
Spray poison	8 (40%)
Using Scarecrows	4 (20%)
Shouting	3 (15%)
Throw Stone	5 (25%)
Setting up Trap	11 (55%)
Put up Flags, Firecrackers	1 (5%)
Install the Strap	1 (5%)
Clapping Hand	1 (5%)
Total number of Respondents	20

Table 7 lists several potential methods that can be used to drive and resolve pest birds' problems. Farmers tend to develop some useful solutions either in terms of local solutions such as shouts, hand-clapping, drumming, stoning, casing, trapping, and use of pesticides or by non-lethal control cages, nets, and fibres, bird scares, repellents, sound-making device, chemical poisoning or trapping. Each of technique has its pros and cons. To improve the quality of the crop, farmers will have to gain sufficient experience with the application of traditional pest birds control methods [21].

Table 7 Potential methods that can be used to drive and resolve pest birds' problems based on the literature review

No	Author	Paper	Method
1	Maurice <i>et al.</i> , 2019	The control methods used by the local farmers to reduce Weaver bird raids in Tiko farming area, southwest region, Cameroon	Lethal method (example: using poison and setting up a trap and non-lethal methods (example; using scarecrow, hand-clapping)
2	Kasmawan <i>et al.</i> , 2018	Utilization of Bali's traditional acoustic tools as a physical repellent of bird pests on rice paddy crop	Physical repellent
3	Khoomsab, R. & Khoomsab, K., 2019	Extraction and Determination of Anthraquinone from Herbal Plant as Bird Repellent	Chemical repellent
4	Ramadan <i>et al.</i> , 2020	WSN is Based on Agricultural Bird Pest Control with Buzzer and a Mesh Network	Buzzer and a Mesh Network

Other than lethal and non-lethal methods, physical repellent is also used to prevent pest birds' problems. The use of Bali's traditional musical instruments as a physical deterrent to birds that damage the rice paddy crops. In Bali, farmers' most common acoustic equipment to ward off pest birds is the *kepuakan* followed by the *pindekan*, *Pecut*, and *kulkul*. *Kepuakan* is used because it is thought to be more practical in fending off avian pests in rice paddy crops. Out of the 127 respondents, 80.3% indicated that *kepuakan* is the most efficient order of acoustic tools, followed by *pecut* (10.2%), *pindekan* (8.7%), and *kulkul* (0.8%). All the traditional equipment is Balinese handicraft product [22].

Additionally, studies using chemical repellent found that the anthraquinone molecule can be found as anthraquinone glycoside and free anthraquinone [23]. All plant parts contain anthraquinone, including the roots, rhizomes, fruits, flowers, and leaves. Most of these substances have as their fundamental building block anthracenedione, a tricyclic aromatic chemical substance with the formula C₁₄H₈O₂ [24]. The use of chemical repellents is crucial for preventing bird grazing on crops. Anthraquinone is a stable chemical with low toxicity for animals and birds and is practically insoluble in water. Finding and creating a licensed, efficient bird-repellent chemical can be a time-consuming, difficult, and expensive procedure [25].

Apart from this, another method that can control pest birds' problems is using advanced technologies by used Buzzer and a Mesh Network. Building a wireless sensor network can therefore be used to monitor pest birds in rice fields and to deal with them by making enough noise using a buzzer. The Passive InfraRed sensor (PIR) sensor has an area of around seven meters and an ideal detection distance of about five meters. The technology will keep track of, find, and eliminate avian pests. Five nodes are required, four of which are stations with installed PIR sensors and one of which is an access point for the internet [26].

Passive Infrared Sensor (PIR) is a gadget that uses infrared radiation to detect motion. The sensor detects a sudden shift in infrared energy when birds walk by and send a signal. In conclusion, since hearing is the most adaptable and efficient form of bird communication, it is possible to use acoustics to manage bird populations by interfering with the birds' ability to communicate and causing behavioural or physiological changes in the bird [27]. Since birds' hearing is more sensitive than humans, with a range of 1–5 kHz, the sort of sound utilized for bird control is audible and audiosonic [28].

Vineyard damage is considerably reduced by more advanced noise deterrents that accurately and effectively imitate bird sounds. The sonic net is another somewhat effective noise deterrent that interferes with bird vocalizations' frequency range, preventing flock communication [29].

4. Conclusion

A total of five pest birds were successfully identified in this study which is, Purple Swamphen (*P. porphyrio*), Lesser Whistling Duck (*D. javanica*), Scaly-breasted Munia (*L. punctulata*), Javan Munia (*L. leucogastroides*), and Baya Weaver (*P. philippinus*). The behaviour of Purple Swamphen (*P. porphyrio*) as a pest bird at Sawah Ring, Tangkak was investigated, such as flocking, feeding, resting, nesting, and preening during this study. Several potential solutions based on the literature review were identified such as physical and chemical repellent, buzzer and mesh networks, and acoustic tools. Further research is needed to better understand pest birds' distribution, ecology, and management. Besides that, similar research should be expanded in other paddy field areas so that the data obtained is strengthened and integrated pest management can be applied for pest birds in all areas.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: **study conception and design:** Maizatul Leeqa Razalee, Nor Atiqah Norazlimi; **data collection:** Maizatul Leeqa Razalee; **analysis and interpretation of results:** Maizatul Leeqa Razalee, Nor Atiqah Norazlimi; **draft manuscript preparation:** Maizatul Leeqa Razalee, Nor Atiqah Norazlimi. All authors reviewed the results and approved the final version of the manuscript.

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